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(54) Title: TRANSGENIC PLANTS EXPRESSING A PROKARYOTIC AMMONIUM DEPENDENT ASPARAGINE SYNTHETASE

(57) Abstract

The gene asnA which encodes a prokaryotic ammonium-specific asparagine synthetase (ASN-A) can be introduced into plant cells. Such transformed cells and plants developed therefrom not only tolerate glutamine synthetase inhibitors but are effectively stimulated by such herbicides.

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Description

Transgenic plants expressing a prokaryotic ammonium dependent asparagine synthetase

Asparagine plays an important role as a transport form of nitrogen and in many plants - including nitrogen fixers - it is the principle compound involved in the transfer of nitrogen from the roots into the transpiration stream. In plants asparagine is formed from glutamine, aspartate and ATP catalyzed by the asparagine synthetase ASN (E.C. 6.3.5.4) whereby glutamate, AMP and pyrophosphate are formed as by-products.

It now has been found that the prokaryotic, ammonium dependent asparagine synthetase ASN-A (E. C. 6.3.1.1) can be introduced into plant cells, resulting in transgenic plants which show a number of advantages: The plants show a more efficient net photosynthetic CO_2-fixation, an increased growth rate, accelerated plant development, earlier flower formation, increased green mass and plant dry weight. Thus, the growth area can be extended to regions with a less favourable climate and in regions with a warm climate e. g. three instead of two crops are possible. Furthermore, the transgenic plants tolerate the application of glutamine synthetase (GS) inhibitors, e. g. phosphinothricine (PPT) or methionine sulfoximine (MSX) and even show a stimulation of photosynthesis and growth upon application of such inhibitors.

In contrast to the ASN encoding gene (or genes) of higher plants (asn gene) the asnA gene of E. coli codes for a different type of ASN which uses ammonium rather than glutamine for the production of asparagine (Cedar and Schwartz (1969) J. Biol. Chem. 244, 4112-4121). The gene for this enzyme has been isolated and characterized by Nakamura et al. (1981) Nucleic Acids Research 9, 4669-4676. It was found that this prokaryotic enzyme is active in plants and

it opens a new ammonium assimilation pathway in these transgenic plants. It results in an overall change of the plant nitrogen metabolism with a stimulatory effect on growth and green mass production.

Under normal conditions in the transformants both GS and ASN-A use ammonia. The advantage of the bacterial pathway will be more pronounced during darkness when the chloroplast GS activity is limited by the reduced availability of ATP, energy charge and magnesium ions (O'Neal and Joy (1974) Plant Phys. 54, 773-779; Joy (1988) Can. J. Bot. 66, 2103-2109). Moreover, the expression of the bacterial asn-A gene in plants even allows an assimilation of ammonia when the plant GS is blocked by specific inhibitors like PPT. In non-transformed plants the inhibition of GS activity disturbs the main road of ammonia utilization and the accumulation of ammonium is one of the key factors in lethality of the treated plants (Tachibana et al. (1986) J. Pesticide Sci. 11, 33-37). Thus the presence of the bacterial enzyme can reduce the ammonia accumulation in PPT-treated transgenic plants which so not only can survive doses of herbicides which are lethal for wild-type plants but rather the so treated transgenic plant shows growth stimulation.

It is apparent for a skilled person that these positive effects are not limited to the asnA gene from E. coli since other bacteria contain the same gene or a gene having the same capability of amidating asparaginic acid and its salts to yield asparagine.

Thus the invention relates to the use of a prokaryotic asnA gene in a plant cell, a gene construct comprising a gene encoding a prokaryotic asnA, operatively linked to a regulatory sequence which effects the expression of the said gene in a plant cell, a vector containing such a gene construct, a plant cell transformed with such a gene

construct or vector and expressing a prokaryotic ammonia specific asparagine synthetase in a plant, especially a crop plant, and seeds or propagation material of such plants which contain transformed cells as hereinbefore defined.

Preferred embodiments comprise the use of the E. coli asnA gene encoding the said enzyme and synthetic genes encoding the said enzyme, especially genes comprising codons which are preferably used by plants. The invention also comprises genes which encode enzymes having a different amino acid composition than the natural enzymes but with essentially the same catalytic activity by deleting or adding codons or by replacing codons in the natural genes by such which encode a different amino acid. All such modifications are within the ordinary skill of persons involved in this art.

Example I
Expression of the E. coli asnA gene with the RUBISCO small subunit promoter in tobacco

1. Production of transgenic tobacco plants

Based on the complete nucleotide sequence of the asnA gene from E. coli (Nakamura et al., (1981) Nucleic Acids Research 18, 4673, Fig. 3) we recloned the PstI-HgaI fragment from the plasmid pMY114 into pUC9. Then the asnA gene (1.1 kb) was linked to the promoter of the small subunit gene for pea ribulose 1,5-bisphosphate carboxylase ("RUBISCO", Herrera-Estrella et al. (1984) Nature 310, 115-120) and the whole fragment was introduced into the Agrobacterium vector pPCV001 (Koncz and Schell (1986) Mol. Gen. Genet. 204, 383-396). After leaf disc transformation of SRI tobacco plants the transgenic plants were identified on the basis of their kanamycin resistance. Among several transformants we selected two plants (ASP4, ASP5) which showed tolerance against treatment with 1 kg/ha PPT. As result of this PPT

treatment the SRI control plants were completely killed and we could never find outgrowings with a capability for flowering and seed production. The ASP4 and ASP5 transformants showed symptoms only on the lower and older leaves while the meristematic region could overcome the inhibition. After continuation of growth these plants flowered and produced seeds.

Selfing the ASP4 and ASP5 transgenic tobacco plants has resulted in a segregating seedling population with resistant and sensitive sexual progenies. Under the in vitro conditions used the presence of 10 µM L-PPT in the culture medium could clearly discriminate between the two phenotypes.

The presence of the asnA sequence in the genome of the transformants was also shown by Southern DNA hybridization. After digestion of plant DNAs with EcoRI a hybridizing fragment was revealed in the transformed plants. In Northern hybridization analysis, a low amount of mRNA which was homologous to the asnA gene was detected in the total RNA isolated from the in vitro grown ASP5 transformant.

2. Reduced ammonia accumulation in transgenic tobacco plants

The inhibition of GS activity by PPT treatment causes a rapid increase in ammonia concentration in leaves of control tobacco plants. The rate of ammonia accumulation measured with the microdiffusion method and subsequent nesslerization (Shelp et al. (1985) Can. J. Bot. 63, 1135-1140) depends on the concentration of the applied herbicide.

At a dose of 0.5 kg/ha the transgenic plants can overcome the effects of PPT treatment (Tab. 1).

Table 1
Accumulation of ammonia in control tobacco plants (SR1) and in transgenic plants with the asnA gene after spraying with 0.5 kg/ha PPT

hours	ammonia concentration (mM)		
	SR1	ASP4	ASP5
up to 4	0.58	0.42	0.40
6	1.20	0.82	0.78
24	1.70	0.70	0.75
48	1.95	0.60	0.50

A reduced level of accumulation can also be seen in these plants in comparison to SR1 tabacco plants after spraying with 1 kg/ha (Tab. 2). The detected lower ammonia level will be responsible for the less pronounced damage of transformated plants.

Table 2
Effects of 1 kg/ha PPT on ammonia concentration in tobacco (SR1) and transgenic plants (ASP4, ASP5)

hours	ammonia concentration (mM)		
	SR1	ASP4	ASP5
up to 6	0.8	0.78	0.88
8	2.2	0.87	0.95
24	4.9	2.0	1.40
48	8.6	4.1	3.6

3. Stimulation of plant growth and development

Detailed comparison of growth behaviour between control and ASP plants revealed considerable differences: An increased growth rate was characteristic for the transgenic plants but a more significant stimulation was achieved by treatment of ASP plants with low doses of PPT.

The basic as well as the PPT induced acceleration in growth

could be demonstrated by various types of growth curves. Fig. 1 shows that while the spraying with 0.025 kg/ha PPT already inhibited the growth of SR1 plants a large stimulation was detected in both of the transformants. Spraying with 0.05 kg/ha PPT has a negative influence on all plants. Each point represents the average height of three plants.

The differences between the various lines under control and treated conditions are also detectable if we characterize the growth of plants by Baule Mitscherlich-curves (Fig. 2) under greenhouse conditions. The inhibition and stimulation of growth can be followed by the slope of plots with characteristic alpha angles shown in Fig. 2.

4. Increased dry weight in transgenic plants

In addition to the differences in plant height the stimulatory effects were also detectable by measuring dry weight. The data shown in Table 3 demonstrate the higher productivity of the asnA transformants:

Table 3
Final dry weigth (gr) of control (SR1) and transformants (ASP4, ASP5)

Lines	Treatment			
	Control		0.025 kg/ha PPT	
SR1	3.19	100 %	2.76	100 %
ASP4	3.85	120 %	4.79	173 %
ASP5	3.74	117 %	5.05	183 %

Example II

Effect of the asnA gene driven by the CaMV35S promoter in transgenic plants

1. Selection of transgenic plants

As an alternative approach we have introduced plasmid molecules (pUC) carrying the E. coli asnA gene with the CaMV35S promoter into SR1 leaf protoplasts by direct DNA uptake (R. X. Fang et al. (1989) The Plant Cell 1, 141-150). The transformants were directly selected on the basis of their PPT resistance. Plants were regenerated from micro calli grown in the presence of 10 µM L-PPT. The Southern hybridization confirmed the presence of the asnA gene in DNA isolated from the PPT resistant regenerants.

2. Reduced ammonia accumulation and improved PPT tolerance in transgenic plants

Selfing of regenerated transformants resulted in segregating progenies with various levels of PPT resistance (medium supplemented with up to 30 µM L-PPT).
In agreement with the resistant phenotype the transformed plants accumulate less ammonia than the SR1 plants when sprayed with 1 kg/ha PPT (Tab. 4).

Table 4
Ammonia accumulation after spraying the plants with 1 kg/ha PPT

hours	ammonia concentration (mM)		
	SR1	ASP70	ASP95
6	6.85	2.92	1.95
24	9.50	5.60	5.10
48	22.3	13.60	17.40
120	58.60	28.30	35.6
144	113.00	39.40	50.00

3. Efficiency of photosynthesis

Both the control SR1 and transgenic tobacco plants were characterized by various parameters of photosynthesis such as the CO_2 fixation rate (Szajko et al. 1971, Acta Agr. Acad. Hung. 20, 247-260) and fluorescence induction (Hideg et al., 1986, Photobiochem. Photobiophys. 12, 221-230). Under greenhouse conditions the plants were treated with various doses of PPT and the content of ammonium was also determined. As shown by Table 5 the transgenic plants with the ASN-A gene exhibit a considerable increase in efficiency of net CO_2 fixation in comparison to the control plants. Application of low dose PPT treatment can further stimulate CO_2 fixation, while the difference between SR1 plants with or without PPT (50 g/ha) treatment is not statistically significant. The Table 5 provides also evidence that in the case of tobacco plants the inhibitory concentration of PPT causes ammonium-accumulation with serious damage in photosynthesis by inhibition of electron transport and a 50 % reduction of CO_2 fixation. Under the same conditions the transformed plants (ASP 70) can tolerate the treatment as the photosynthetic function is concerned.

Table 5
Parameters of photosynthesis

Lines	PPT treatment (g/ha)	Ammonia concentration (mM)	CO_2 fixation (μmol CO_2/dm^2xh) $\bar{x}$	$\pm s_{\bar{x}}$	n	P 1%	Fluorescence induction (in % of control SRI) F_m	F_o	F_i-F_o/F_m-F_o
SR1	0	0.37	38.17	12.05	20	-	100	100	0.45
	50	2.00	44.23	17.73	20	-	101	102	0.44
	750	34.35	19.54	12.42	20	+	80	194	0.59
ASP70	0	0.47	49.32	7.86	20	+	98	114	0.38
	50	2.70	58.07	6.06	20	+	99	110	0.42
	750	15.80	31.61	14.16	20	-	92	144	0.49

The analysis was carried out 4 days after PPT treatment.

4. Growth behaviour of asnA transformant plants

Analysis of growth rate (mm/day) reproducibly showed accelerated growth of transformants during the early plant development. Data are shown in Table 6 for plants grown in the green house.

Table 6
Growth rate (mm/day) during various periods of plant development (green house)

Lines	Periods (6 days) I	II	III	IV	V	VI	VIII	VIII	Final plant height (cm)	
SR1	0.29	0.45	0.27	0.52	0.75	1.31	1.93	1.37	41.08	
Asp70/1	0.60	1.15	0.43	1.23	1.83	2.08	1.53	0.50	58.0	141 %
Asp70/2	0.61	0.93	0.50	0.75	1.18	1.51	1.83	0.25	48.5	118 %

SR1: average of 5 plants
ASP70/1 and ASP70/2: individual plants

The analysis of these plants under field conditions revealed similar differences as it was observed in the green house (Table 7). The growth rate of ASP plants during period I-III was considerably higher than in the case of SR1 plants. In this experiment the stimulatory effect of PPT on the transgenic plants was also confirmed especially in the last growing period. The Baule-Mitscherlich curves (Fig. 3) clearly demonstrate that the ASP plants exhibit faster growth than control SR1 plants grown in the field.

Table 7
Growth rate (mm/day) during various periods of plant development (field experiment)

Treatment	Lines	Periods (7 days)				Final plant height (cm)	
		I	II	III	IV		
Control	SR1	0.36	0.85	1.31	3.24	42.5	100 %
	Asp70	0.45	1.07	1.50	3.14	47.6	112 %
	Asp95	0.48	1.14	1.92	3.24	51.5	121 %
25 g/ha PPT	SR1	0.29	0.56	1.15	2.74	35.0	100 %
	Asp70	0.44	1.02	1.69	3.84	53.8	154 %
	Asp95	0.31	0.88	1.27	3.78	48.7	139 %

Average of 5 plants

5. Productivity of asnA transformants
As shown by Table 8 the total green mass as well as the dry weight was increased in ASP plants in comparison to SR1 plants. Here we can also see that the transgenic plants are significantly stimulated by PPT treatment. At the same time the control SR1 plants are already inhibited by the spraying.

Table 8

Gr en mass (gr)
field test

	Control				25 g/ha PPT			
Lines	Total	%	Leaf	%	Total	%	Leaf	%
SR1	86.5	100	57.4	100	78.7	100	43.4	100
ASP70	95.2	110	62.3	108	139.9	178	92.41	213
ASP95	103.8	120	68.4	119	105.0	133	71.56	165

Dry weight (gr)
field test

	Control				25 g/ha PPT			
Lines	Total	%	Leaf	%	Total	%	Leaf	%
SR1	6.66	100	4.83	100	6.42	100	5.05	100
ASP70	8.05	121	5.82	120	10.99	171	8.56	169
ASP95	8.48	127	6.34	131	8.96	140	6.78	134

All average data from 5 plants

Claims:

1. A plant cell expressing a prokaryotic ammonium-specific asparagine synthetase (ASN-A).

2. A plant, seeds or propagation material, containing cells as claimed in claim 1.

3. A gene construct comprising a gene encoding a prokaryotic ASN-A, operatively linked to a regulatory sequence which effects the expression of said gene in a plant cell.

4. A gene construct according to claim 3, wherein said ASN-A is an E. coli ASN-A.

5. A gene encoding E. coli ASN-A consisting of plant specific codons.

6. A gene construct comprising the gene according to claim 5 under the control of a regulatory sequence active in plants.

7. A vector containing a gene construct according to claims 3, 4 or 6.

8. A plant cell transformed with a gene construct according to claims 3, 4 or 6 or with a vector according to claim 7.

9. The use of a prokaryotic asnA gene in a plant cell.

10. The use of an E. coli asnA gene in a plant cell.

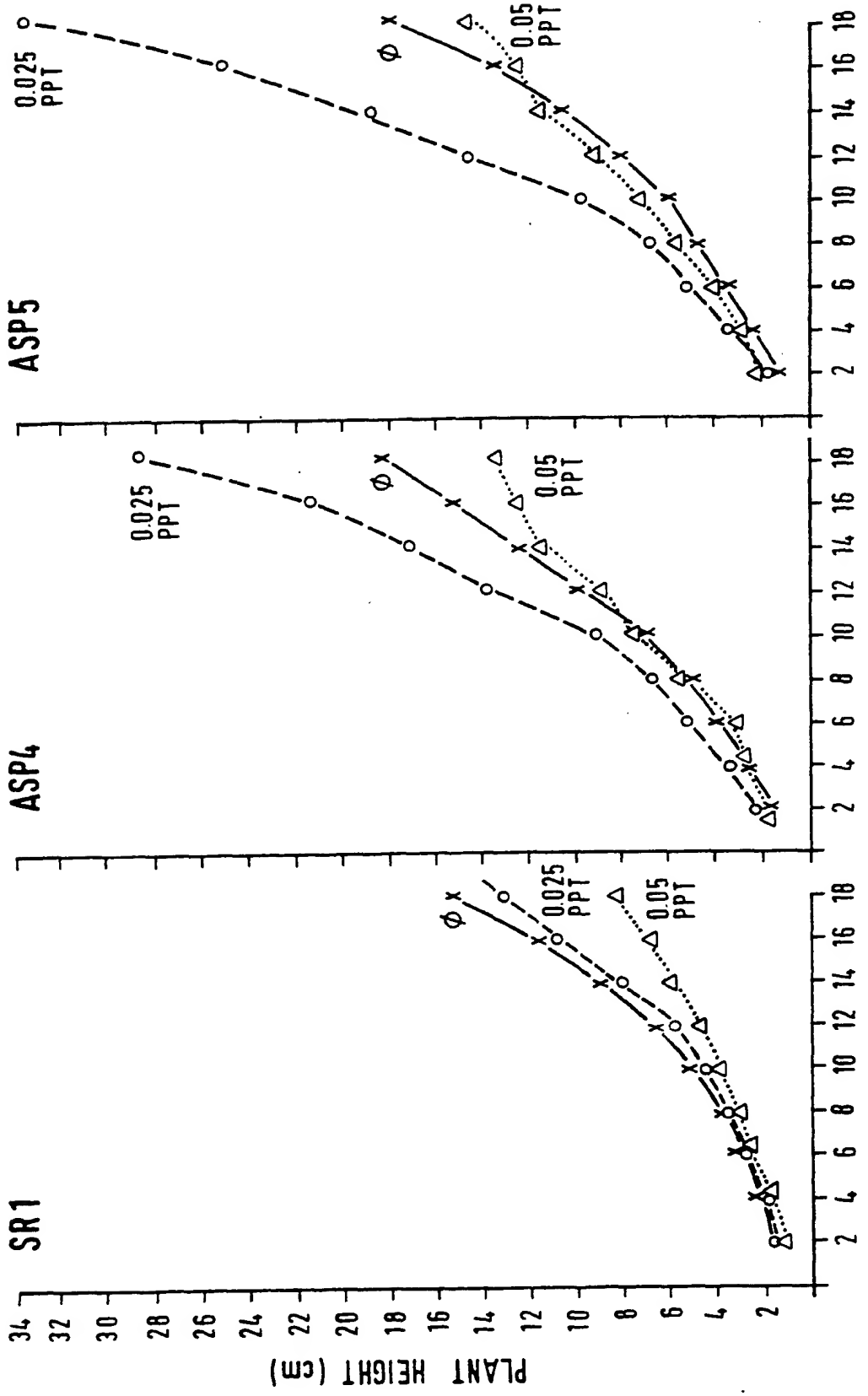

Fig. 1

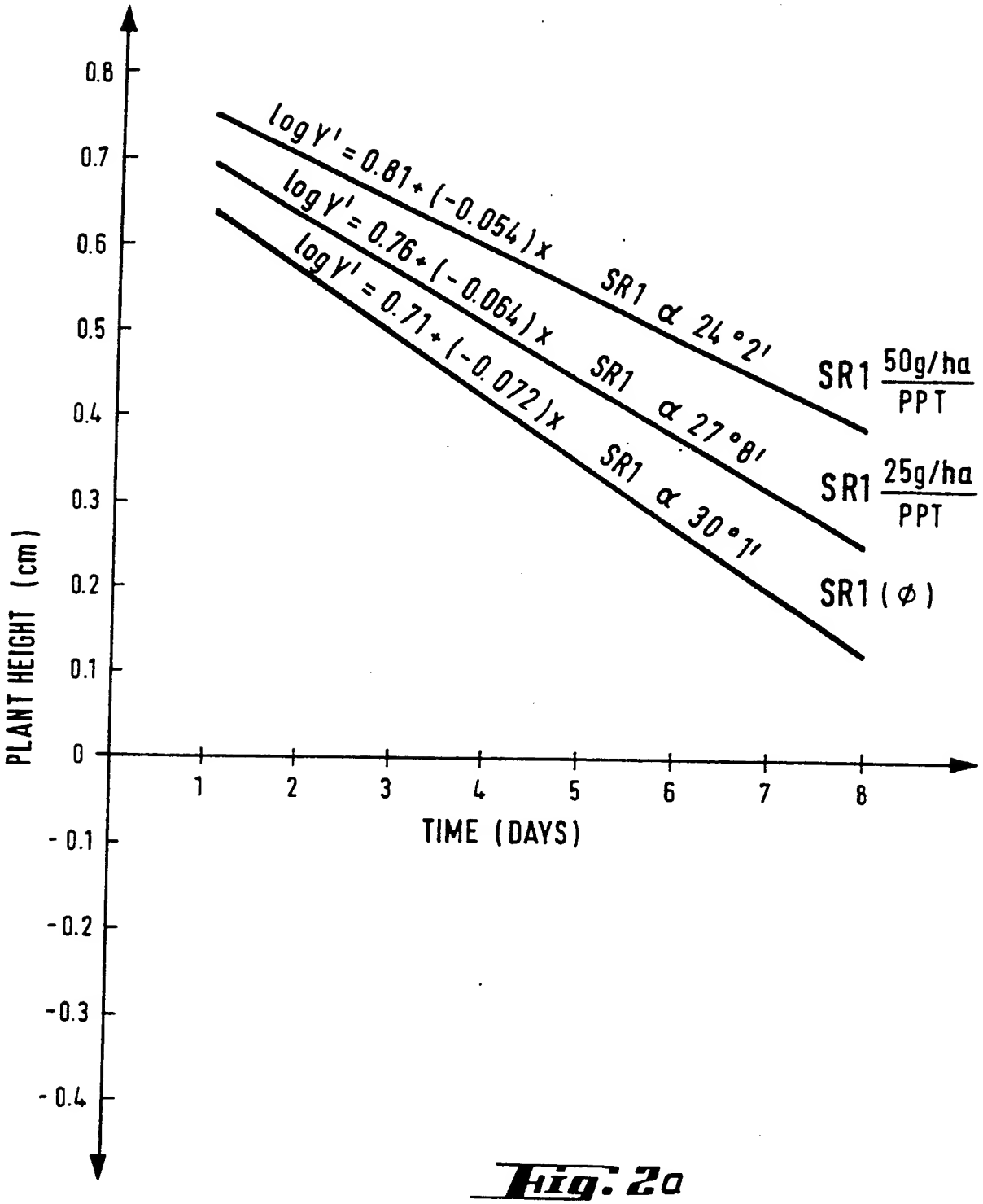
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
PLANT HEIGHT (cm)
1
2
3
4
5
6
7
8
TIME (DAYS)
log Y' = 0.81 + (-0.054) x
SR1 α 24°2'
log Y' = 0.76 + (-0.064) x
SR1 α 27°8'
log Y' = 0.71 + (-0.072) x
SR1 α 30°1'
SR1 50g/ha PPT
SR1 25g/ha PPT
SR1 (Ø)

Fig. 2a

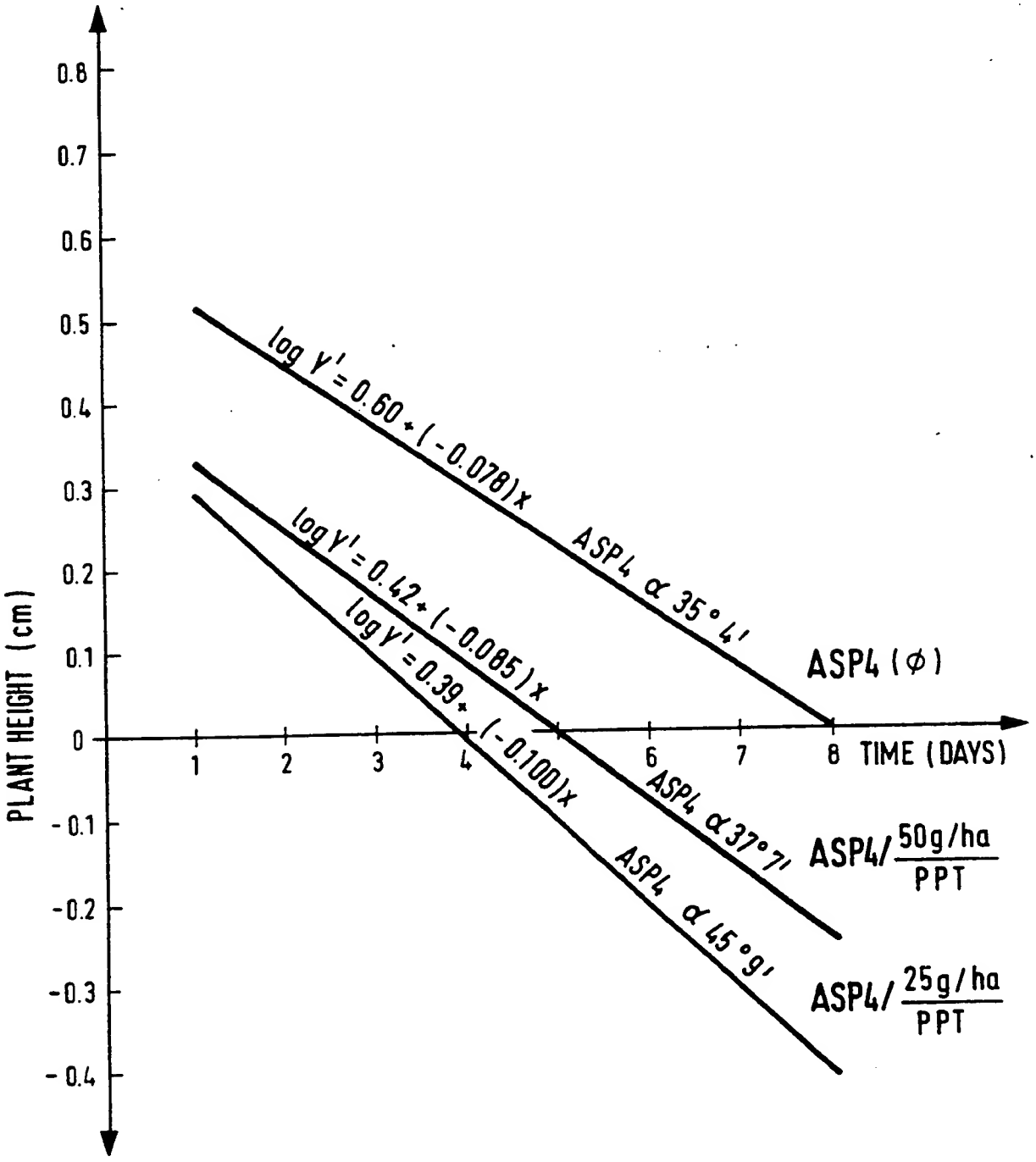
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
PLANT HEIGHT (cm)
1
2
3
4
6
7
8 TIME (DAYS)
log Y' = 0.60 + (-0.078)x
ASP4 α 35° 4'
ASP4 (Φ)
log Y' = 0.42 + (-0.085)x
ASP4 α 37° 7'
ASP4/ 50g/ha PPT
log Y' = 0.39 + (-0.100)x
ASP4 α 45° 9'
ASP4/ 25g/ha PPT

Fig. 2b

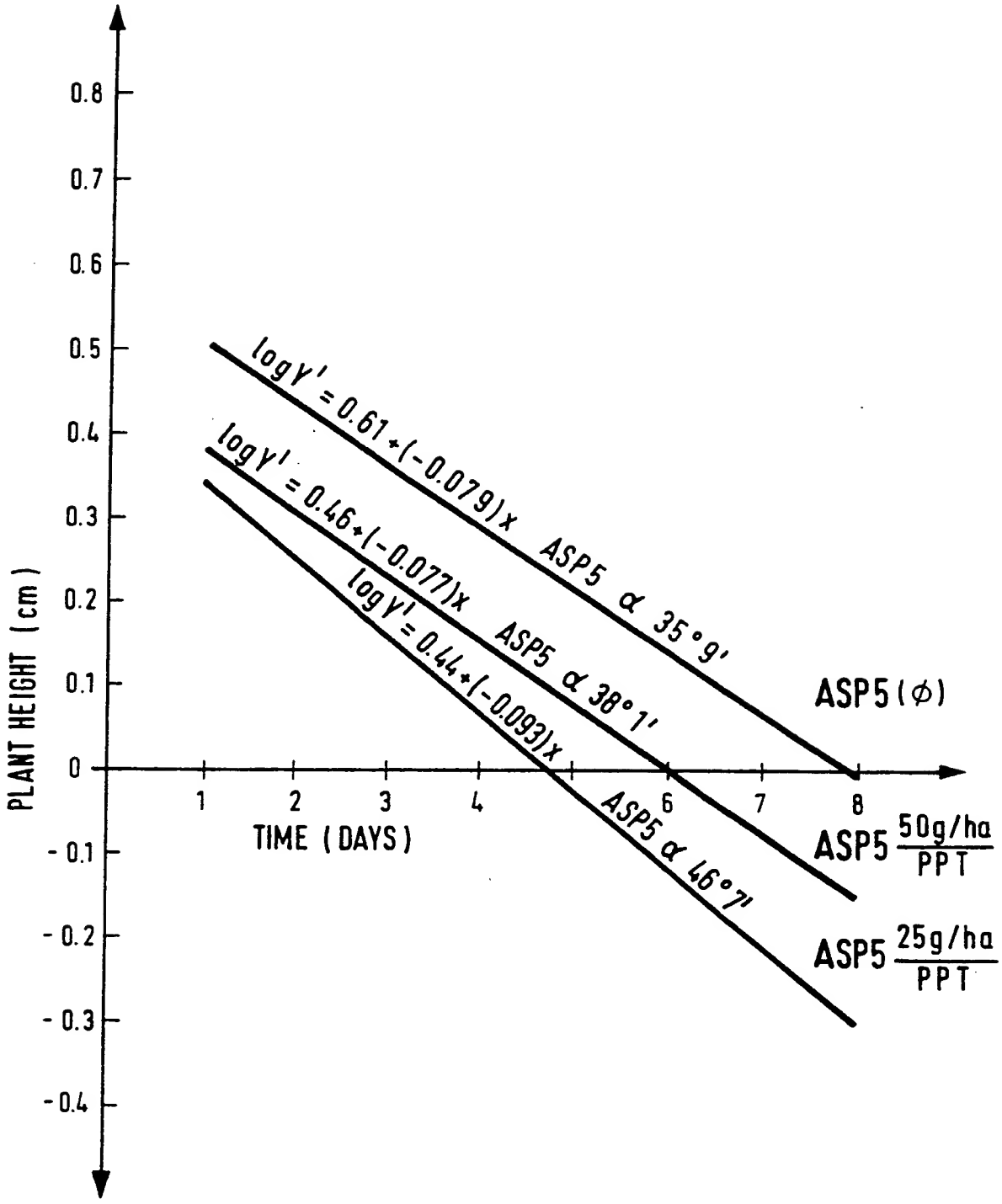
PLANT HEIGHT (cm)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
- 0.1
- 0.2
- 0.3
- 0.4
1
2
3
4
6
7
8
TIME (DAYS)
log Y' = 0.61 + (- 0.079) x
ASP5 α 35° 9'
log Y' = 0.46 + (- 0.077) x
ASP5 α 38° 1'
log Y' = 0.44 + (- 0.093) x
ASP5 α 46° 7'
ASP5 (Φ)
ASP5 50g/ha PPT
ASP5 25g/ha PPT

Fig. 2c

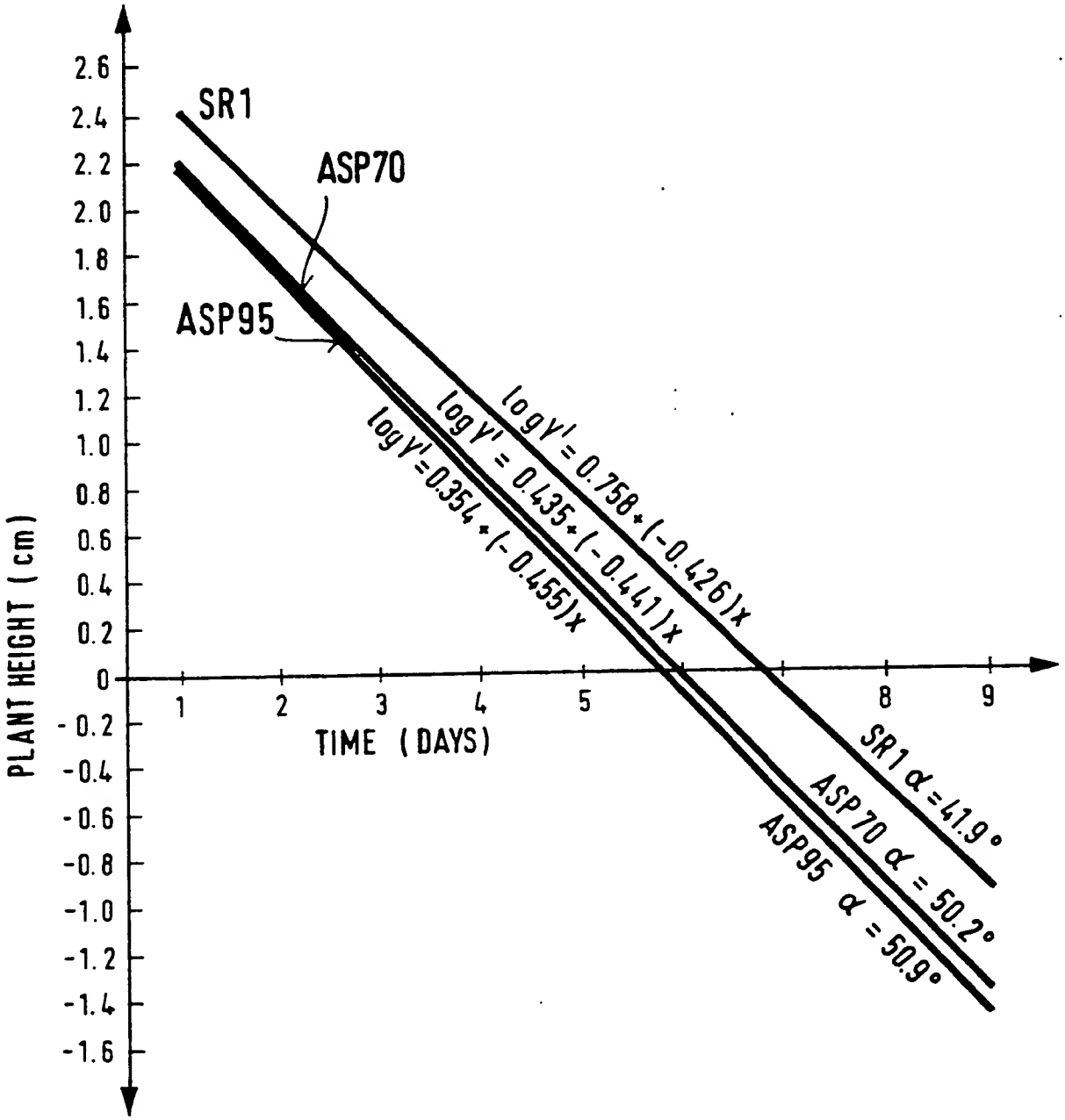
SR1
ASP70
ASP95
log Y' = 0.758 + (-0.426)x
log Y' = 0.435 + (-0.441)x
log Y' = 0.354 + (-0.455)x
SR1 α = 41.9°
ASP70 α = 50.2°
ASP95 α = 50.9°
PLANT HEIGHT (cm)
TIME (DAYS)
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
-1.6
1
2
3
4
5
8
9

Fig. 3

INTERNATIONAL SEARCH OR

International Application No PCT/EP 91/00120

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[5]: C 12 N 15/82, C 12 N 15/52, C 12 N 5/10, A 01 H 5/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[5]	C 12 N, A 01 H

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
P,Y	WO, A, 9013633 (ROCKEFELLER UNIVERSITY) 15 November 1990 see the whole document	1-10
Y	Chemical Abstracts, volume 98, 1983, (Columbus, Ohio, US), M.M.W. Waye et al.: "Direct transfer of the bacterial asparagine synthetase gene to mammalian cells", see page 169, abstract no. 192668s & J. Mol. Appl. Genet. 1983, 2(1), 69-82	1-10
A	Mol. Gen. Genet., volume 217, 1989, Springer-Verlag, P. Eckes et al.: "Overproduction of alfalfa glutamine synthetase in transgenic tobacco plants", pages 263-268 see the whole document	1-4,7-10

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* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
25th April 1991	04 JUN 1991
International Searching Authority	Signature of Authorized Officer
EUROPEAN PATENT OFFICE	MISS T. TAZELAAR

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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FR M THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	EP, A, 0275957 (HOECHST) 27 July 1988 see the whole document	5-8
A	EP, A, 0303780 (HOECHST) 22 February 1989 see the whole document	1-4,7-10

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. EP 9100120 SA 43701

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A- 9013633	15-11-90	AU-A- 5645190	29-11-90
EP-A- 0275957	27-07-88	DE-A- 3737918	02-03-89
		AU-A- 1061988	28-07-88
		JP-A- 63273479	10-11-88
		ZA-A- 8800368	05-07-88
EP-A- 0303780	22-02-89	DE-A- 3719053	15-12-88
		AU-A- 1732188	08-12-88
		JP-A- 1060389	07-03-89